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THE IMPORTANCE OF ANIMAL INFECTIONS FOR THE HUMAN*

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CONTENTS: A review is made of the present status, following a brief general introduction, of the most important diseases and infections in the Central European area caused by bacteria, viruses, fungi, and protozoa.
BACTERIAL ZOOANTHROPONOSES: Salmonella, Pasteurelloses (tularemia), Brucelloses, Erysipeloid, Listeriosis, anthrax, tuberculosis, leptospiroses.
VIRUS-CAUSED ZOOANTHROPONOSES: Rickettsioses, ornithosis, lyssa, arboviroses.
FUNGUS-CAUSED ANIMAL-HUMAN INFECTIONS: filamentous fungus, yeast fungus.
PROTOZOA DISEASES: Toxoplasmoses.

Introduction

A number of infection-caused human diseases have a significant connection with animals in their epidemiology, since these diseases are transmitted from the animal -- directly or indirectly -- to the human. Diseases of this type, that are transmitted to the human, are designated as zooanthroponoses or more briefly, zoonoses. They include infection diseases -- caused by bacteria, viruses, protozoa, fungi -- and invasion diseases --caused by worms, mites, or other insects. The animal involved may be a symptomless disease carrier, without being actually sick itself, acting as an infection reservoir or as an intermediate carrier. In addition to the direct animal-to-human infection chain, indirect transfer to the human through animal products may also take place.

The infection danger for the human depends :

1) On the frequency of the animal disease involved.

2) On the possibility of infection. Human groups in closer contact with animals are therefore exposed to risk to a greater extent.

3) On the virulence and number of the active infection carriers.

* cf. Inaugural address, Muenster, 21 Dec 1965.

4) On the possibility of the existence of a human-to-animal infection chain after transfer of the infecting agent from the animal to the human. Most zooanthroponoses end abruptly in the human.

The infection may take place:

a) By means of infection through the alimentary tract and, less frequently, by means of aerogenic infection,

b) by means of contact with live or dead animals,

c) by means of products from live animals (such as milk) or dead animals (meat, hide, wool, hair).

In most cases, the pathogenesis and the clinical syndrome are the same in the human and in the animal. In some types of human infections originating from animals, however, the syndrome is different in the human from that in the animal. This is especially the case in parasitic diseases if the parasite (such as worms) is in another state of development in the human than in the host animal (host change).

It is to be expected that the zooanthroponoses will become less frequent as a consequence of improved public health and hygienic measures, based on appropriate regulations such as laws dealing with animal diseases, meat inspection, duck-egg laws, Federal insect control laws, and the like. This has been, and still is, the case in other respects: examples that may be cited in this connection include bovine tuberculosis, anthrax, the pest, spotted fever, and worm infections. On the other hand, further knowledge in the field of zooanthroponoses became available with changes in the biotopes, increased international travel, and advances in clinical and laboratory diagnostics, especially in virology. Of especial interest in this connection is the increased degree of collaboration between human and veterinary medicine.

I. The bacterial zooanthroponoses

1. Salmonella

Salmonella are still the most important sources of infection: widely spread among the animals and capable of being transmitted directly or -- as in most instances -- indirectly to the human. The various Salmonella species are differently pathogenic to the animal: this represents a difficulty in the epidemiological research. Salmonella species possessing a high degree of pathogeneity in the host animal, such as the originator of hog disentery, equine abortus, or mouse typhoid, are easier to detect in the animal stock, thereby lessening the danger to the human. If, however, the animal is a symptomless germ carrier, such as the duck for S. enteritides, it creates a constant unkown danger source for the human. The extent to which Salmonella are widespread among animals and animal products became evident during the past years when international commerce reached new heights. A great number of hitherto unknown Salmonella species attained a great degree of significanc through direct or indirect contact by animals or their products as a consequence of importation of meat, dried animal products, feathers, fodder, etc., especially since Salmonella disease in a human may be a factor in further infection chains among humans.

2. Parvobacteriaceae

A number of microorganisms belong in the family of gram-negative small bacteria; these also occur in animals and may represent a source of disease in humans through direct or indirect transfer.

Among the Pasteurelloses, the pest was a particularly dangerous scourge. At this time it has merely a medical-historical interest in Europe. Since it is known that the pest is primarily a disease of rodents, efforts to achieve rat extermination and thus the fight against rat fleas, the transmitter of rat pest from the rat to the human, resulted in a decisive change in the events. The pest has no significance any longer.

The human is infected by the germ-carrying rat flea during the biting action. In some cases, the germ-containing flea settles on the skin and is scratched into the body when the person attempts to relieve the itching sensation. Also, the flea's omasum, filled with bacteria (up to 5000) may empty into the biting channel through regurgitation in the act of biting. The disease carrier has a long lifetime within the body of the flea (up to one year); this favors the dissemination of the pest which, in turn, may then migrate from human to human through aerogenic uptake of pest bacteria.

Since insects transmit diseases only very seldom, and furthermore since a human-to-human infection chain does not exist, Tularemia, a disease that in some respects resembles the pest, did not assume the characteristics of a general epidemy. The epidemiology of tularemia, one in the Pasteurellose group and one that has been given its name by the area where first encountered (Tulare, California), is most interesting. The disease, first observed in Europe in the East, South, and West, progresses slowly from the east towards the west between the 35th degree of latitude and the Polar circle and has now engulfed Central Europe and is near the boundaries of Spain and Italy. Instances of human affliction became known in Germany since 1943. The disease seems to flourish in areas where the precipitation is low, less than 1000 ml. per annum, and covered by steppe vegetation. The geoclimatic conditions favor the spread of rodents among which tularemia subsequently causes mass deaths. The principal repository for the germ in Eastern Europe is the migrating rat, now joined in this capacity by the field mouse. In Central Europe this role is played by rabbits and jack-rabbits, probably also by the muscrat; in Northern Europe by the lemmings. This distribution among the animals listed is not precisely known at this time: it may possibly be related to the geoclimatic conditions.

Infection may cause in humans either a local syndrome with lymph node affliction or a typhoid-like syndrome.

The brucelloses are just as significant as the Pasteurelloses. Three species of the Brucella genus may cause the clinical syndrome of brucellosis:

1) Brucella abortus, causing the 'Bang disease,'

2) Brucella melitensis, causing the 'Maltese fever,' and

3) Brucella suis, first encountered in Northern Europe and North America, now encountered more and more frequently in Central Europe.

Brucella melitensis and Brucella suis appear to be the most pathogenic towards humans.

It appears that goats, cattle, and hogs are preferentially afflicted by a specific type of germ, designated by terms such as caprine, bovine, and provocine. It should be noted, however, that World War II caused a considerable shift in terms of the endemic spread within the animal herds and also of the geographic distribution of the various types. As the name indicates, Maltese fever (a term that the Maltese do not like) was initially confined to the Mediterranean sea area. The Bang disease was encountered mainly in the more moderate zones; brucellosis caused by Brucella suis in Northern Europe and North America. The Melitensis brucellosis migrated to Germany through Southern France, Alsasse-Lorraine, Rhineland, Pfalz, the Mosel valley, and Hunsrueck, towards the end of the war. Central Europe is now fully covered by this type of brucellosis, and as a result of the severe clinical course in the human, assumed an increasing degree of significance. Not only sheep and goats are carriers of this disease, however. It spreads from the sheep to cattle; even the protective dog becomes a latent carrier, a fact that is very important in the epidemiology and spread of Melitensis brucellosis. Finally, the field rabbit may also become infected. It is a proven fact that the habitat of the animals is infected by the excretions (urine, milk, miscarriage, genital secretions) of diseased animals and, to an even greater degree, of latently infected animals, whereby the meadows, fodder, and stables assume the greatest degree of significance. The mortality was between 0.5% and 90% in the sheep herds investigated in South-West Germany. In the Duesseldorf area, the average degree of infection among the sheep herds was 50%. Between 1948 and 1955, 130 sheep became afflicted with Melitensis brucellosis in Rhineland-Pfalz, with a lethality of almost 6%.

In contrast to the abortus-brucellosis animal-animal-human infection chain, one that usually ends blind in the human, the infection chains of the other brucelloses, especially that of the Maltese fever, are characterized by the fact that they permit also a direct and an indirect human-to-human infection potential. Of course, practitioners of professions involving contact with sheep, goats, and cattle are especially vulnerable, particularly shepherds, farmers, and doctors of veterinary medicine. Sheep-shearers and meat handlers may become afflicted also, as may be even the gardener; three rabbit breaders who mowed the grass at meadows and railway right-of-ways where sheep had previously grazed, contracted Melitensis brucellosis.

3. Gram-positive bacteria

Only the causative agents of erysipelas and Listeriosis are of any significance among the group of gram-positive bacteria as zoonthroponoses.

Hog erysipelas is transferred to such persons primarily who in their work handle diseased meat (pork); these persons are most likely infected. They develop primarily a localised disease in the form of an erysipeloid. The causative agent, E. insidiosa, earlier designated as E. rhusiopathiae, is excreted from the diseased animals with urine or feces which in turn contaminate the soil wherein they are quite long-lasting. Dissemination among the animals is effected mainly by germ uptake from the soil or

the grazing field. Diseases of this type are therefore also designated by the term: roaming diseases. Thus, one can talk about a soil scourge, an affliction that has a specially good chance of spreading during the summer. However, the causative agent may survive the winter and cause infections anew next spring. The economic damage caused by it, as by other animal diseases, is considerable.

The causative agent is not restricted to the hog alone: it is also encountered in wild animals, fowl, and fish. This fact should come as no surprise in view of the resistant nature of this widespread germ, one that holds especially tenaciously in running media such as effluent waters. Sea-fish are not primary carriers of the causative agent; they are mainly infected by germ-containing containers of deep-sea fisheries. Humans are not readily infected. There exists no human-to-human infection chain.

Insofar as resistance against external influences is concerned, the causative agent Listeria monocytogenes, causing Listeriosis, takes no second place behind the erysipelas bacterium. These two show several similarities in their epidemiological behavior. Listeriosis is the most recent disease among the bacterial zooanthroponoses -- the causative agent was discovered as late as 1924. It assumed major significance in human medicine only during the fifties; then, relevant veterinary research was initiated as a consequence of this factor. The epidemiological relations are not entirely clear in case of Listeriosis, a fact that is partly the result of the multifarious clinical syndrome in the animal and in the human. The symptoms encompass the range from local infection to severe septic conditions. The following findings were established during the last fifteen years:

1. The causative agent is widely spread, owing to its high degree of resistance.

2. Many of the animals in habitats surrounding human settlements can become afflicted with Listeriosis, thereby becoming both germ carriers and germ secretors.

3. Humans may become infected by animals through direct and indirect contact, especially with insects as the intermediates.

4. Human-to-human transfer is possible. The most frequently encountered means is diplacental transfer from the mother to the fetus during pregnancy.

In spite of the relatively frequent possibility of infection of humans, the disease does not occur very frequently, apparently because of the essential constitutional and dispositional factors for the onset of the infection.

The incidence distribution with respect to the timely occurrence in the animal and in the human is quite different. In animals, especially in sheep, the seasonal peak is during the late winter months, whereas in humans these months represent the lowest incidence in terms of disease occurrence.

Some problems are still awaiting elucidation. These include the question as to whether diseases in humans indeed occur in localized clusters; the reasons for the changes in the occurrence of the individual serum types; whether there are clinically healthy human germ excretors (a fact that must be assumed according to recent studies in Denmark.)

4. Anthrax

Animal anthrax, a disease caused by an aerobic bacterium and one that is transmitted primarily to humans who are in contact with diseased animals and their products (including hides and bristles), represents a zooanthroponosis that has been combated successfully by public-health measures. The mean annual morbidity in the [German] Federal Republic was 0.04/100,000 inhabitants between 1955 and 1960; i.e., four instances of the disease in ten million inhabitants.

5. Tuberculosis

Fortunately, the measures against cattle tuberculosis, and thus also against bovine tuberculosis, were most successful in Germany. As a consequence, the significance of this disease in human medicine is of no further significance. Maybe one should now ask the following question: What means are available from preventing the tuberculosis-free stock of cattle from being reinfected by carriers of an undiagnosed tuberculosis carrier?

6. Spirocheta

Leptospiroses are the most important among the spirocheta infections occurring in animals and capable of being transmitted to humans. A total of 42 types are known for this disease genus, among which approximately ten are significant in the European region. The most important among the latter are those responsible for the WEIL disease (L. icterohaemorrhagiae), the field fever (L. grippotyphosa), dog pest (L. canicola), and hog-skin disease (L. pomona and L. mitis). Small rodents such as mice and rats, and, as disease occurrences suggest, most domestic animals, are the repositories of the germs. Rodents are disease carriers and dischargers without clinical symptoms of disease. This factor makes the danger of infection in humans especially high. With respect to the spreading of the infection and to the danger to humans, the fact that the germs are secreted from the afflicted kidney via urine is of particular significance. The epidemiological significance of leptospiroses in animals and through these in humans increases with increasing spread of the rodents and with increasing degree of affliction among the rodents. The infection chain usually stops dead in the human since, unlike animal urine, human urine is of an acidic character. Leptospirae are pronouncedly vulnerable to acidic pH values.

The human usually has no direct contact with the germ-spreading animal; the disease-causing agents are, depending on the ambient conditions, picked up from damp soil, wet grass, and water. This pickup can take place also through the unbroken skin. Thus, leptospiroses may be designated as 'sought-out diseases.' The geographic distribution of the various types is of interest; it apparently reflects the various living conditions of the disease carriers. The relatively high incidence of L. pomona infections in hogs in Switzerland may reflect the type of hog raising practised there in large communities. Most leptospirose incidences in humans are encountered during the summer and the autumn, reflecting the climatic conditions of the reproduction and living habits of the rodents. The possibility of an occupational disease in this respect is of importance with respect to insurance considerations for the farmer population, particularly if infection

is detected after the incubation period of the type involved.

II. Rickettsia infections

All rickettsioses have in common a continuous fever of approximately two weeks duration and an exanthema. All rickettsioses, except the spotted fever and the Q-fever, are natural infections of wild rodents from which the infection sometimes may spread to humans through ectoparasites.

The Q-fever, also called the Balcan grippe and the significance of which in relation to humans became established only during World War II, is transmitted in most instances without the intermediary function of ectoparasites. Infection of humans takes place mainly through inhalation of dust that contains dry feces contaminated with disease-causing agents from lice and ticks. Since ectoparasites such as ticks may bite other warm-blooded animals such as cattle, infection with Rickettsia burneti, the agent responsible for the Q-fever, may also take place through consumption of meat or milk. Infection from one human to another is also possible since the disease-causing agent is discharged with sputum and urine. The possibility of mass disease outbreaks, for example through travelling groups passing through infected areas anywhere in the world, cannot be discounted.

III. Virus infections

As the knowledge about virus etiology of infectious diseases in humans became more advanced, the number of virus diseases capable of being transmitted from animals to humans increased also. Diseases such as yellow fever, where insects act merely as connecting links in the human-to-human infection chain, may not be classed in this category.

Ornithosis, also called psittacosis in earlier days, is no longer restricted to decorative birds. The ornithosis virus is encountered in wild birds and fowl also without causing a clinical disease in these animals after infection. In this case also, the symptomless virus carrier represents an especial danger to humans. Since the virus is capable of causing disease and infection in humans both by direct and indirect transmission (for example, through dust containing disease-causing agents), the danger is not restricted solely to persons who handle pigeons, ducks, turkeys, or other fowl. In Czechoslovakia, on the other side of the borderline, ducks assumed an epidemiological significance with respect to the spreading and transfer of ornithosis among humans. In Germany, especially in Central Germany, poultry-processing plants were identified as endemic ornithosis reservoirs. The risk of infection for humans continues to increase as a consequence of the increase in the number of wild pigeon colonies (up to 40% serologically positive) in large cities, in the number of homing-pigeon breeding sites (85% serologically positive in Koblenz), and in the number of ornamental pigeons in gardens and parks. The pigeons transmit the infection to their progeny through direct contact. It was observed that transmittal may also take place through the egg. The ornithosis virus has been also isolated from various ectoparasites of birds. The epidemiological significance of ornithosis was recognized by its inclusion under the coverage of the federal laws for infectious diseases (mandatory reporting of cases of ornithosis and psittacosis) capable of afflicting humans.

Mobile laboratories operate in Czechoslovakia whenever there is an outbreak of endemic ornithosis. These laboratories are manned by virologists, epidemiologists, and zoologists who are capable of performing the identification and eradication of the zoonoses by methods adapted to the prevailing terrain conditions. In that country this method is employed for other zooanthroponoses also.

The traveler passing through the country will clearly see evidence for the increase of rabies incidence and the consequent danger for humans by reading the signs at the roads leading to municipalities forbidding the entry of dogs owing to a risk of rabies infection. All animals are susceptible to infection by the Lyssa virus; however, only certain specific animals have a degree of significance with respect to the spreading of the virus in the animal-to-animal infection chain. This group of animals includes the bat (vampire) and many carnivores. The spreading rate may depend on the number of carnivores that had been infected. In Eastern Europe, carnivores living in flocks; in our country, fox-like carnivores such as the fox and the dachshund (animals confined to a certain area of the non-roaming type) are the main transmitters. Accordingly, rabies tends to spread slowly in our country. It is also interesting to note that in areas where the biotope is unsuited for mice and hamsters, such as in Scandinavia, there is hardly any occurrence of rabies. Since the lethality of rabies in humans is high, especial significance is attached to anti-disease measures by the police: these measures include mandatory reporting of cases and prophylactic ordinances. Such measures are also recommended by the WHO.

Arbo-viruses represent a special group in the terms of reference of this report. The term arbo-viruses originates from the expression: arthropode-borne viruses. This type of virus multiplies in vertebrae (reservoir) and arthropodes (transfer animals). These considerations do not include those arbo-viruses for which the insect acts merely as a connecting link in the human-to-human infection chain, such as the yellow fever virus. The insertion of ticks and mosquitoes as virus vectors makes it easy to understand that the rythm of the infection depends on the living habits of the host animals involved, and thus on the geoclimatic conditions that prevail in the area. This consideration mainfests itself clearly in the seasonal course of many endemic infections. This tick-borne encephalitis group is important in the European region. The early-summer meningo-encephalitis is in this group: it assumed especial significance in recent years, since this infection was identified in an extensive endemic natural herd in the area of Neunkirchen, Lower Austria. The seasonal peak is in the month of July. Small rodents, forest and field mice, are believed to be the virus reservoirs.

This group also includes the loupingill, the stagger disease of sheep and cattle. In these cases too, infection of humans can occur both through tick-bite and direct contact with diseased animals or products of these (for example: sheep's wool).

The Newcastle disease, an atypical form of poultry pest, has a certain degree of importance for humans since it is widely spread. However, it is mostly of a local nature and manifests itself merely as a harmless affliction of conjunctivitis.

IV. Mycoses

It is an undisputable fact that mycoses, caused by both yeasts and filamentous fungi, are on the increase. They are encountered mainly in the veterinary practice dealing with domestic animals. Diagnosis has been refined, and elucidation of the etiology indicated frequently that the animal with which the patients were in contact is identified as the source of infection. One may argue whether mycoses can be designated as zooanthroponoses in the strict sense of the term, since the animal does not represent the sole infection source to the human in case of a given fungus as is the case in bacterial zooanthroponoses such as brucellosis. However, the subject of this discussion includes not only the zoonoses proper but also the epidemiological significance of animal infections of the human in general.

Damages caused in defense mechanism, for example by parenteral use of corticosteroids, may cause the 'opportunists,' as the fungi are called, to become parasites. The filamentous fungi, such as the causative agent of the dermatomycoses, may all occur in the animal; thus the cat may be the carrier of microspory, the cattle that of trichophyty, and, last but not least, the dog, the 'faithful' companion of men, that of all filamentous fungi capable of being pathogenic for humans. For example, it is not sufficient to combat the human-to-human infection chain in the fight against a microspory epidemy; the measures must be extended to include the potential animal infection sources also. All that has been said about the microspory applies also to the favus.

Trichophyty appears to have an especial significance with respect to the animal-to-human infection chain. This is so since (1) trichophyty may be endemically spread in both laboratory and domestic animals and (2) the possibilities of infection for humans may be manifold on the basis of this factor. Thus, trychophytic infections in the laborstory are commonplace for humans who handle laboratory animals: experience with infected breeds verifies this. Amongst others, the possibility of infection through infected soil cannot be excluded for persons engaged in gardening work.

Fortunately, system mycoses, caused by inhalation of fungi and capable of being transmitted from the animal to the human in the same way as Coccidioides immitis (coccidioidomycosis), are not as significant in our contry as they are in Africa and America.

Among the mycoses caused by yeasts, our main interest is in cryptococcosis, brought about by Cryptococcus neoformans. Pet birds may become infection sources, either directly or indirectly. For humans, the most dangerous manifestation is that afflicting the lungs, partly because one usually does not suspect fungus infection in the course of antibacterial therapy and partly because the suspicion develops only after the failure of any such therapy.

V. Protozoa

Toxoplasmosis shall represent solely all protozoa diseases since in our area it is the most important zooanthropomosis caused by protozoa. It is significant in terms of the degree of infestation established with the aid of serological investigations.

Toxoplasmosis resembles in many respects the above-discussed Listeriosis. This similarity extends to its epidemiology also. The paths of transfer and infection are yet not fully clear. Wherever toxoplasmoses were sought in animals in the neighborhood of humans -- dogs and cats being specifically meant here -- the causative agents were also encountered in all instances. The clinical syndrome may take a great number of forms: the visceral form has a definite significance in addition to the intrauterine transmittal of the causative agent. Microscopic tests and animal tests identify the disease-causing agent often in the lymph nodes. Since toxoplasmosis may occur spontaneously in laboratory animals, it is essential to have toxoplasmosis-free animal stock in animal experiments. Finally, similarities with Listeriosis are also evident in the difference between clinical disease and latent, symptomless infections in both humans and animals -- as already said, mainly on the basis of serological investigations.

A general view of the 'zooanthroponoses' clearly reveals the significance of these diseases for the human. It makes it also easy to understand why so detailed veterinary- and human-medical attention is given to this aspect of epidemiology in neighboring countries. Last but not least, a close collaboration between the two branches of medical science will provide a better understanding of diagnostics, prevention, and prophylaxis.

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